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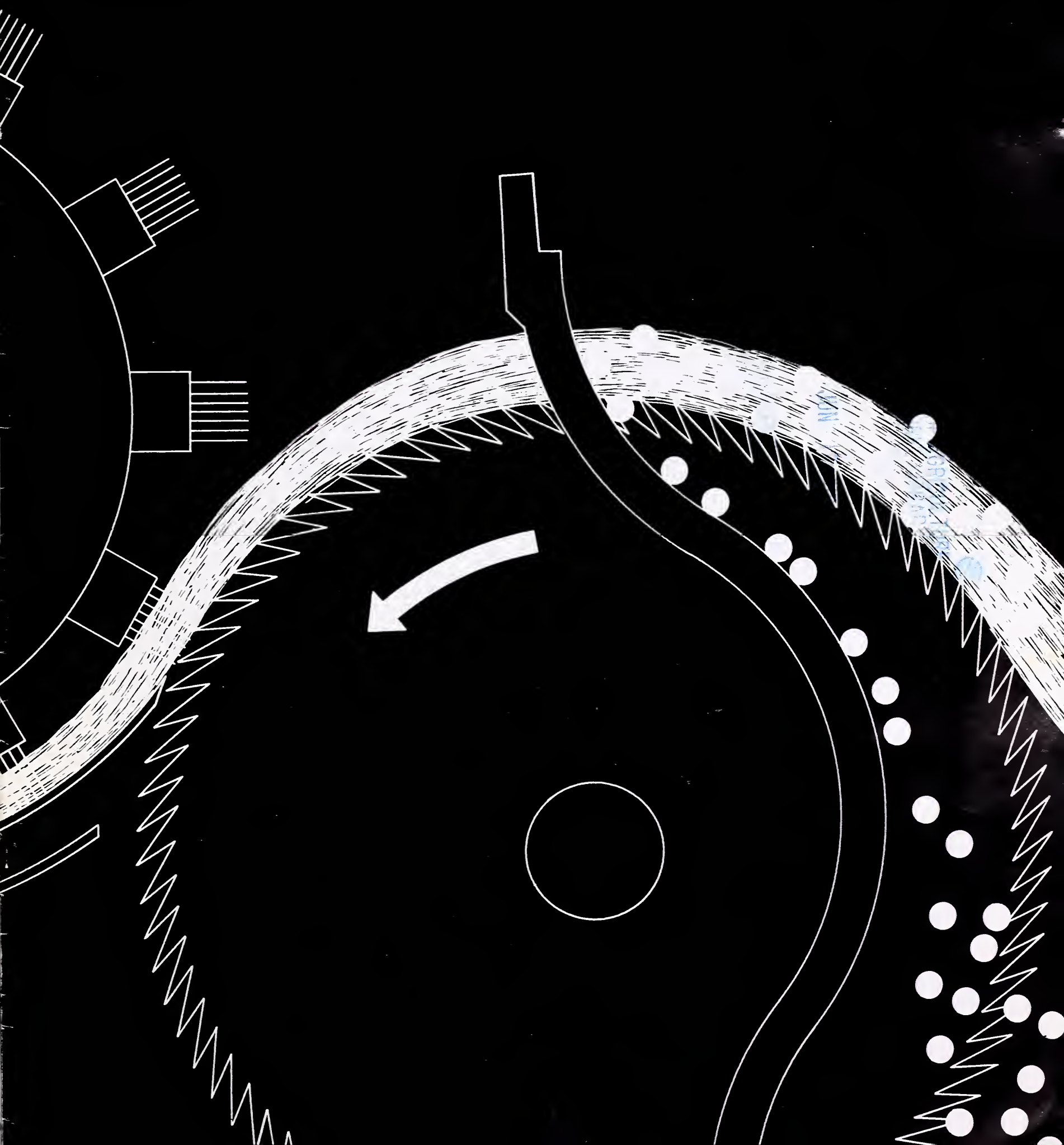
Ginning Cotton to Preserve Quality



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Ginning Cotton to Preserve Quality

by William Mayfield, Roy V. Baker, S.E. Hughes, A.C. Griffin[1]

Cotton fibers must be separated from the seed (ginned) before they can be used to manufacture textile goods. The first machine to gin cotton, the "Churka" gin, dates back to antiquity. This hand-operated gin consisted of two hardwood pinch rollers less than a foot long, one about the diameter of a nickel and the other about the diameter of a dime. As the rollers turned, their surfaces gripped the fibers and pulled them off the seed.

The "Churka" gin was most efficient when handling naked seeded varieties with loosely attached fibers. Early American settlers found that the fuzzy seeded varieties that yielded best in this country were difficult to gin on a roller gin. Consequently, the fiber was generally pulled from the seed (ginned) by hand until Eli Whitney invented his spiked-tooth gin in 1794.

Whitney's gin used spikes on a hand-driven cylinder to remove fibers (lint) from the seed. The spikes pulled lint through slots that were too narrow for the seeds to pass. A revolving brush then removed the lint from the spikes. Whitney's gin could process as much cotton as 100 people could gin by hand. This invention enabled cotton growers to rapidly expand production, and marked the beginning of the modern cotton industry.

Hodgin Holmes received a patent in 1796 for an improved gin that used saws rather than spikes to remove the fibers from the seed. The saws were spaced on a shaft to provide openings that allowed the clean seed to drop. Holmes' invention made ginning a continuous rather than a batch process, and greatly increased capacity. The basic principles developed by Whitney and Holmes are used in modern gin stands, but there have been many improvements.

When cotton was hand picked and carefully handled, the only machines needed in a ginning system were gin stand, a baling press, and conveying equipment. Rougher hand harvesting methods and mechanical harvesters caused more moisture and foreign material (trash) to be mixed with the seed cotton. Thus, seed cotton cleaning and drying equipment and lint cleaners were developed to compensate for the trashier harvesting methods. Cotton is harvested today by three mechanical methods, spindle picking, machine stripping, and machine scrapping. In 1981, 62 percent of the U.S. cotton crop was spindle picked, 37 percent was machine stripped, and 1 percent was machine scrapped.

There is a vast difference (a ratio of about 1 to 7) in trash content of spindle picked and stripped cotton. Thus, each harvesting method requires specific ginning machinery for quality preservation and for producing maximum bale value. Approximately 1,500 pounds of spindle-picked seed cotton is required to make a 480-pound bale of lint. Stripped cotton requires about 2,200 pounds for the same size bale.

On the average, the 1,500 pounds that were spindle picked will contain about 120 pounds of foreign matter, while there will be about 820 pounds of trash in the 2,200 pounds of stripped cotton needed for one bale. The remaining weight in both picking methods is divided into approximately 875 pounds of seed and 25 pounds of mositure.

Storing Seed Cotton

Seed cotton can be safely stored in modules if its moisture content is kept at 12 percent or less. Wet cotton or cotton containing green plant material will heat during storage and quickly deteriorate. Cotton damaged in this manner produces low grades and poor quality seed. Fresh modules should be checked daily. If the temperature inside a seed cotton module exceeds 120° F, the cotton should be ginned to prevent further deterioration.

Modules of dry seed cotton should be carefully formed so water will run off the top and sides, placed on a well-drained site, and covered with tarpaulins which meet or exceed Canvas Products Association International specifications (CPAI-63). Cotton tarpaulins should be used in areas of high humidities and rainfall while plastic may be satisfactory in dry areas.

Cotton rope should be used to anchor the module coverings. Plastic twine should not be used to tie down covers since pieces of this material can get into the cotton and become a serious contamination problem at the textile mill.

Machinery in the Ginning System

Quality preservation during ginning requires the proper selection and operation of each machine that is included in a ginning system.

Automatic Feed Control

Gin machinery operates more efficiently when the cotton flow rate is constant. In early gins the flow rate was often erratic because of the variable work rate of the man operating the unloading system. The automatic feed control was developed to solve this problem by providing an even flow of cotton to the gin's cleaning and drying system. A mechanical module feeder also performs a similar function and may be used to feed seed cotton directly from a module.

Green Boll Trap

The green boll trap is important for removing green bolls, rocks, and other heavy foreign matter from rough cotton. These large, heavy materials should be removed early in the ginning system to prevent damage to machinery and to preserve fiber quality. Green boll traps use sudden changes in flow direction and/or reduced air velocities to separate heavy foreign ma-

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terials from seed cotton. A typical green boll trap is shown in figure 1.

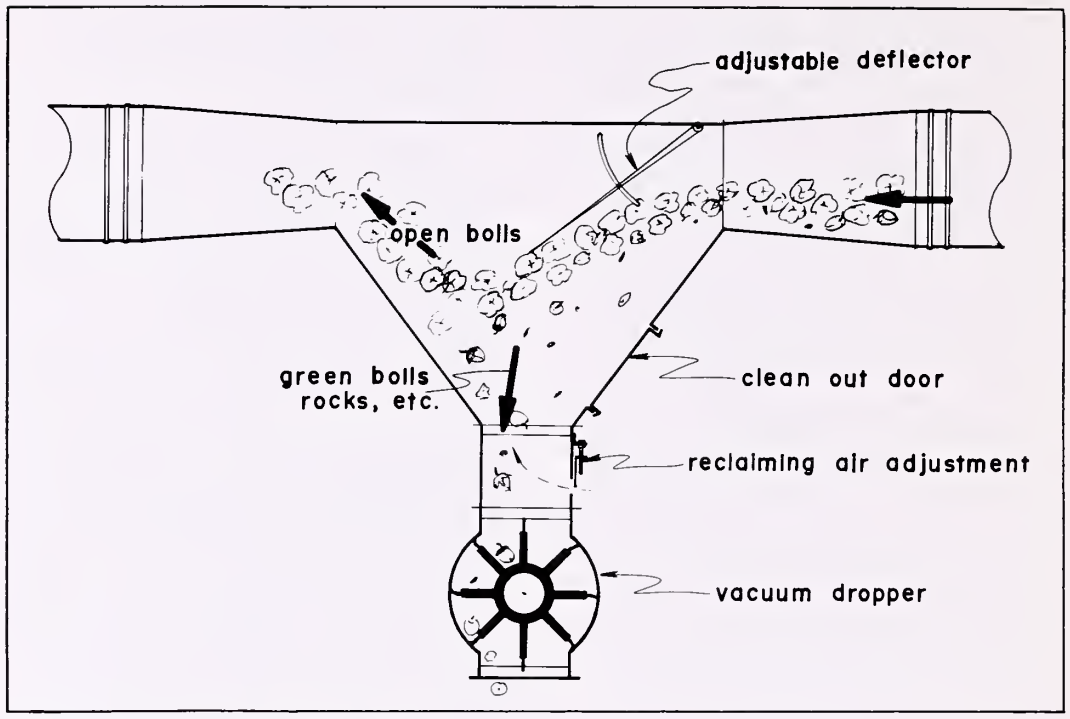


Figure 1: Typical green boll trap.

Driers

The most important factor in preserving quality during ginning is the fiber moisture content. At higher moistures, cotton fibers have more resistance to breakage, but trash is harder to remove and cleaning machinery is less efficient. Consequently, selecting a ginning moisture content is a compromise between good trash removal and adequate quality preservation. For most conditions, cotton should be ginned at 6 to 7½-percent lint moisture.

The tower drier is the most widely used gin drier. Tower driers commonly have 16 to 24 shelves arranged so cotton must slow down while making turns through the machine (fig. 2). Heated air conveys the cotton through the shelves in 10 to 15 seconds. Practically all of the approximately 2,000 active cotton gins in the United States are equipped with at least one stage of seed cotton drying, and most ginning systems have two stages.

The temperature of the conveying air is regulated to control the amount of drying. To prevent fiber damage, the temperature in the drying system should be kept below 350°F. If the temperature sensor in your gin is located near the bottom of the drier, the reading may be 200-240°F lower than the actual temperature at the mix point. The temperature control sensor (or a maximum temperature limit switch) should be located between the burner and the mix point to keep the temperature below 350°F.

Seed Cotton Cleaners

Seed cotton cleaners (cylinder cleaners) consist of six or seven revolving spiked cylinders that turn about 400 r.p.m. (fig. 3). These cylinders convey the cotton over a series of grid rods or screens, agitate the cotton, and allow fine foreign materials such as leaf, trash, and dirt to fall through openings for disposal. In many gins, two cleaners are installed in parallel (split stream), with each one cleaning half the seed cotton.

Seed cotton cleaners break up large wads and generally get the cotton in good condition for additional cleaning and drying. Cylinder cleaners may also be used to remove seed cotton from the hot air line as it comes from the drier. They may be used in either a horizontal position or inclined at an angle of about 30° (inclined cleaners).

Stick Machines

The stick machine (stick and green leaf machine) was developed to remove the extra foreign matter taken from the plant by mechanical harvesters (fig. 4). Stick machines use the centrifugal force created by high-speed saw cylinders to sling off foreign material while the fiber is held by the saw.

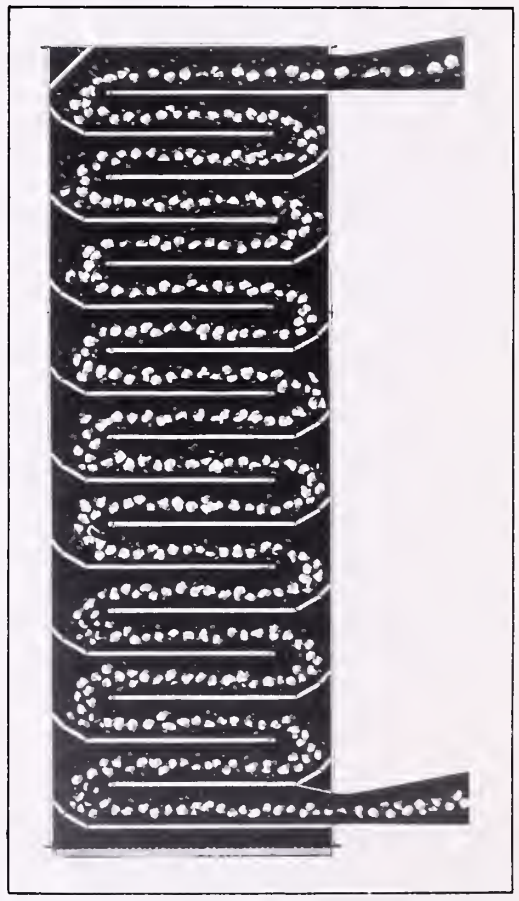
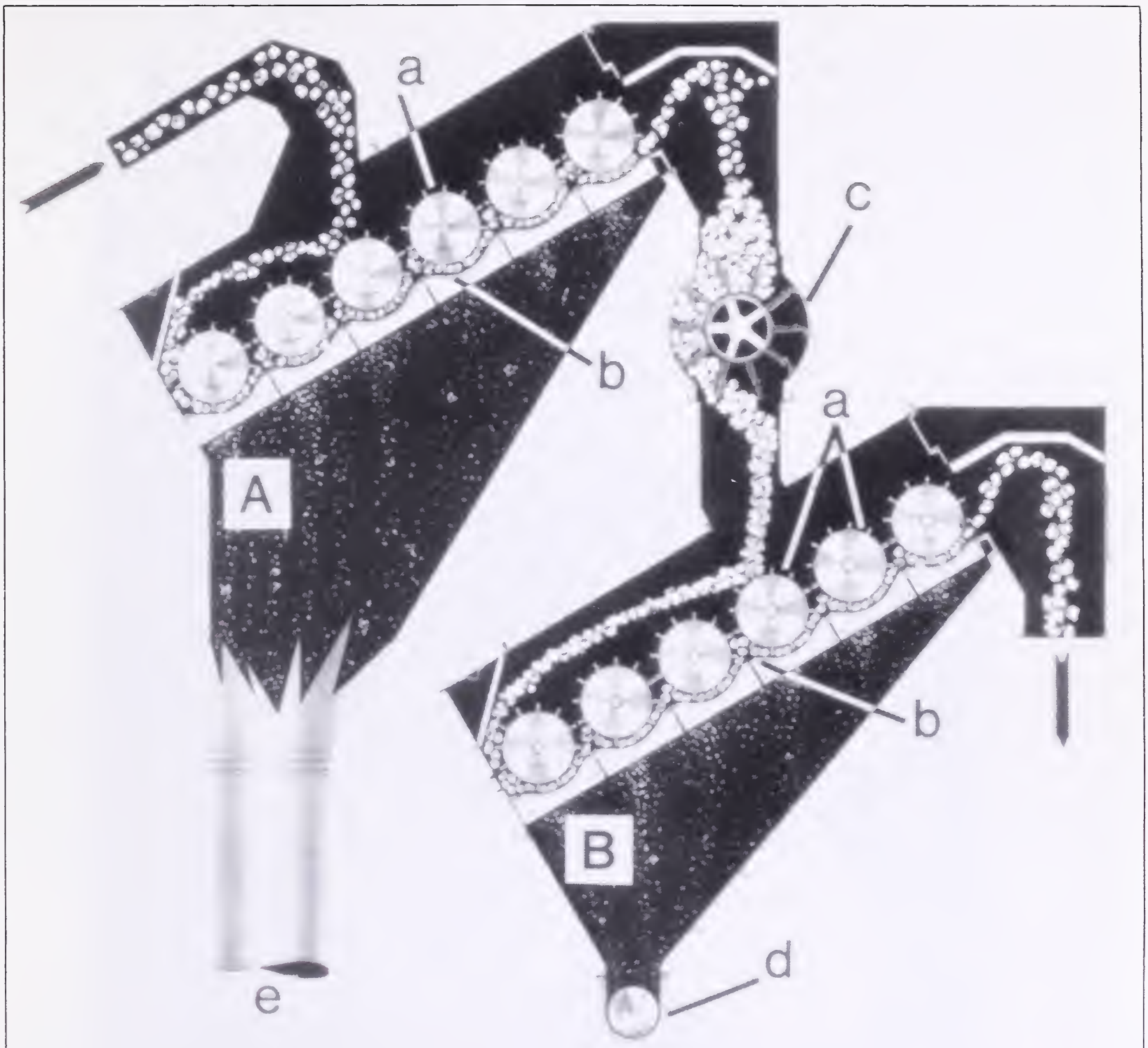


Figure 2: Typical tower drier for seed cotton.



Inside a stick machine, seed cotton is wiped onto the sling-off saw teeth by stationary wire brushes. Grid bars or stationary wire brushes are located around the saw cylinder to reduce the amount of seed cotton that is thrown off the cylinder. Some models have two sling-off cylinders while others use only one.

The seed cotton which is thrown off with the foreign matter is picked up by reclaimer saws and put back into the seed cotton stream. Reclaimer saw cylinders are similar to main sling-off cylinders, but usually run slower and have more grid bars. The foreign matter that is slung off the reclaimer feeds into the trash handling system.

Figure 3: The cylinder cleaner breaks up seed cotton wads for improved drying and removes small foreign matter.

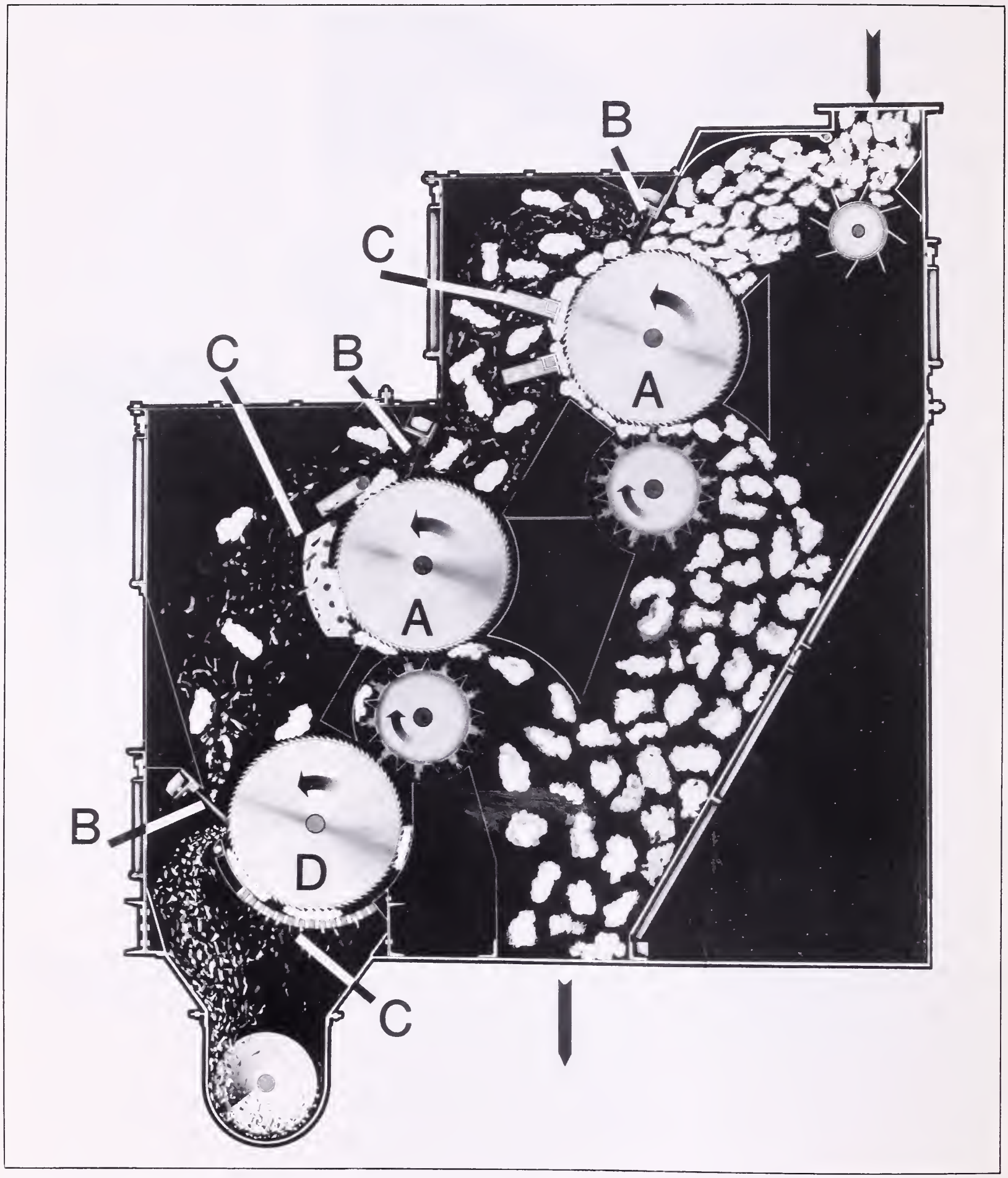
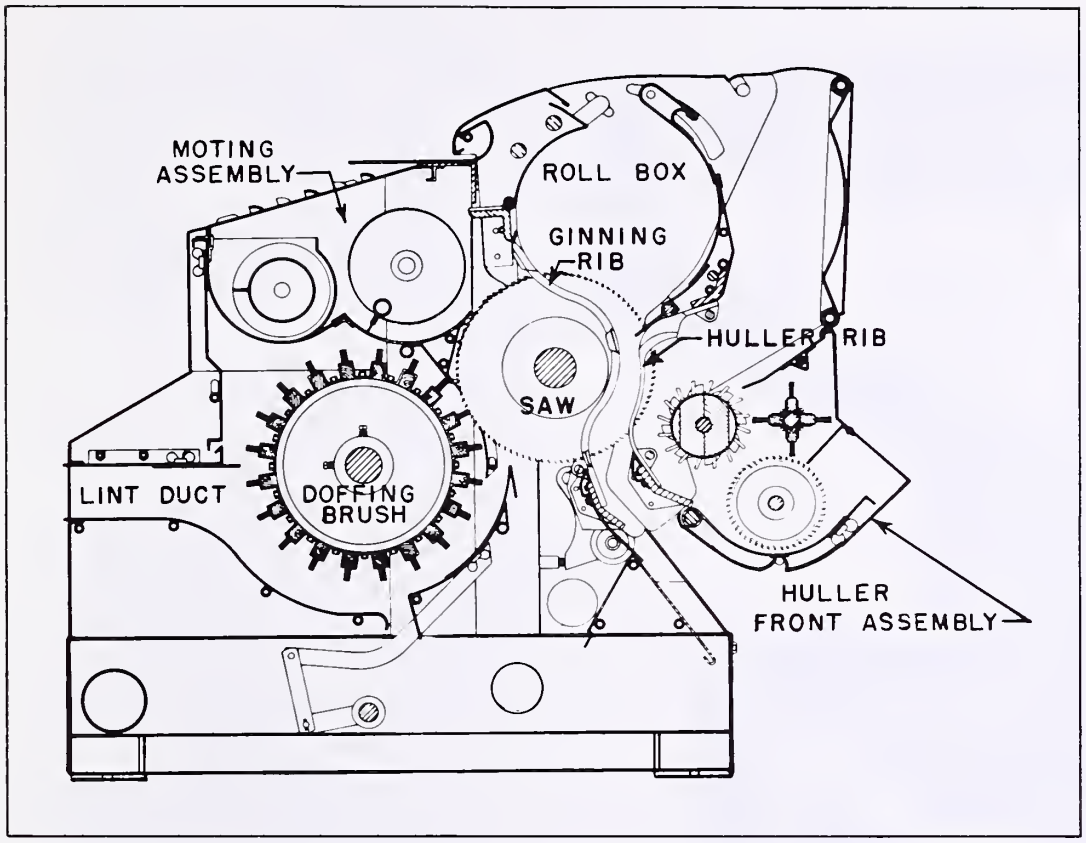


Figure 4: Gravity-fed, two-saw stick machine with brush doffing cylinders.



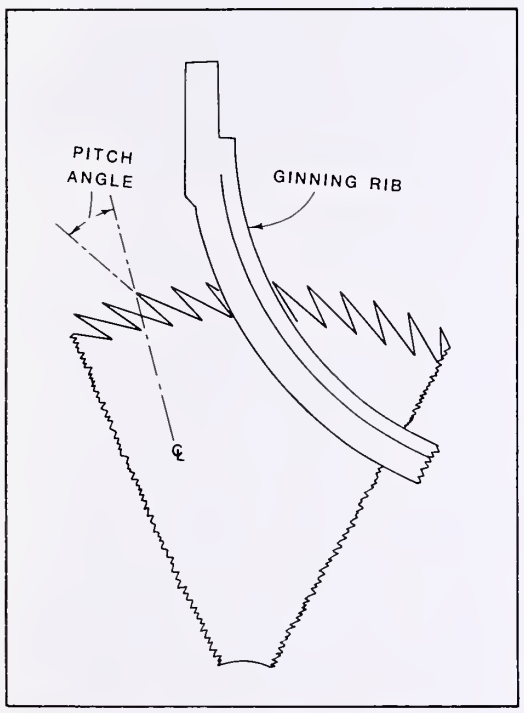


Figure 6: Typical brush-doffed gin stand.

Figure 5: During ginning, the fibers are carried through a slot between the ribs by the saw tooth at right angles to the face of the rib, avoiding a scissors action which would cut the fiber.

Extractor-Feeders

The primary function of an extractor-feeder is to feed seed cotton uniformly to the gin stand at controllable rates. Seed cotton cleaning is a secondary function. Feed rollers, located at the top of the extractor-feeder and directly under the distributor hopper, control the feed rate of seed cotton to the gin stand. These feed rollers are powered by variable-speed motors, controlled manually or automatically by various interlocking systems with the gin stand.

Gin Stand

The gin stand consists of a set of saws rotating between ginning ribs (fig. 5). The saw teeth pass between the ribs at the ginning point. Here the leading edge of the teeth is approximately parallel to the rib to pull the fibers from the seed rather than cutting them.

Cotton enters the gin stand through a huller front (fig. 6). The saws grasp the cotton and draw it (in locks) through a widely spaced set of ribs known as "huller ribs." This causes hulls and sticks to fall out of the machine. The locks of cotton are drawn into the bottom of the roll box from the huller ribs. The actual ginning process (separation of lint and seed) takes place in the roll box of the gin stand. When all the long fibers are removed, the seeds slide down the face of the ginning rib between the saws and fall onto a conveyor. Lint is removed from the saw by a rotating brush or by an air blast. It is then conveyed to the next machine in the ginning system, usually a lint cleaner.

Lint Cleaner

In the lint cleaning process, a condensor removes the fiber from the conveying air stream and forms it into a batt (fig. 7). The batt is introduced to the lint cleaner saw cyliner which normally rotates at approximately 1,000 revolutions per minute. The saws carry cotton over grid bars which, aided by centrifugal force, remove immature seeds (motes) and foreign matter. The cleaned lint is removed from the saw by a rotating brush which also provides air to convey it to the next machine.

Lint cleaners can improve the grade of cotton by removing foreign matter if the cotton has the necessary color and preparation characteristics. Lint cleaners may also blend light spotted cotton so that it becomes a white grade. But fiber length can be damaged by excessive lint cleaning, especially when the cotton is too dry.

For average machine-picked cotton, the first stage of lint cleaning will remove about 20 pounds of lint and foreign matter from each bale. The second lint cleaner would be expected to remove an additional 10 pounds and the third stage about 6 pounds.

Determining the number of lint cleaners that gives maximum bale value is a compromise between increased grade and reduced length and turnout. The price differentials for grade and staple length have a great influence on this decision.

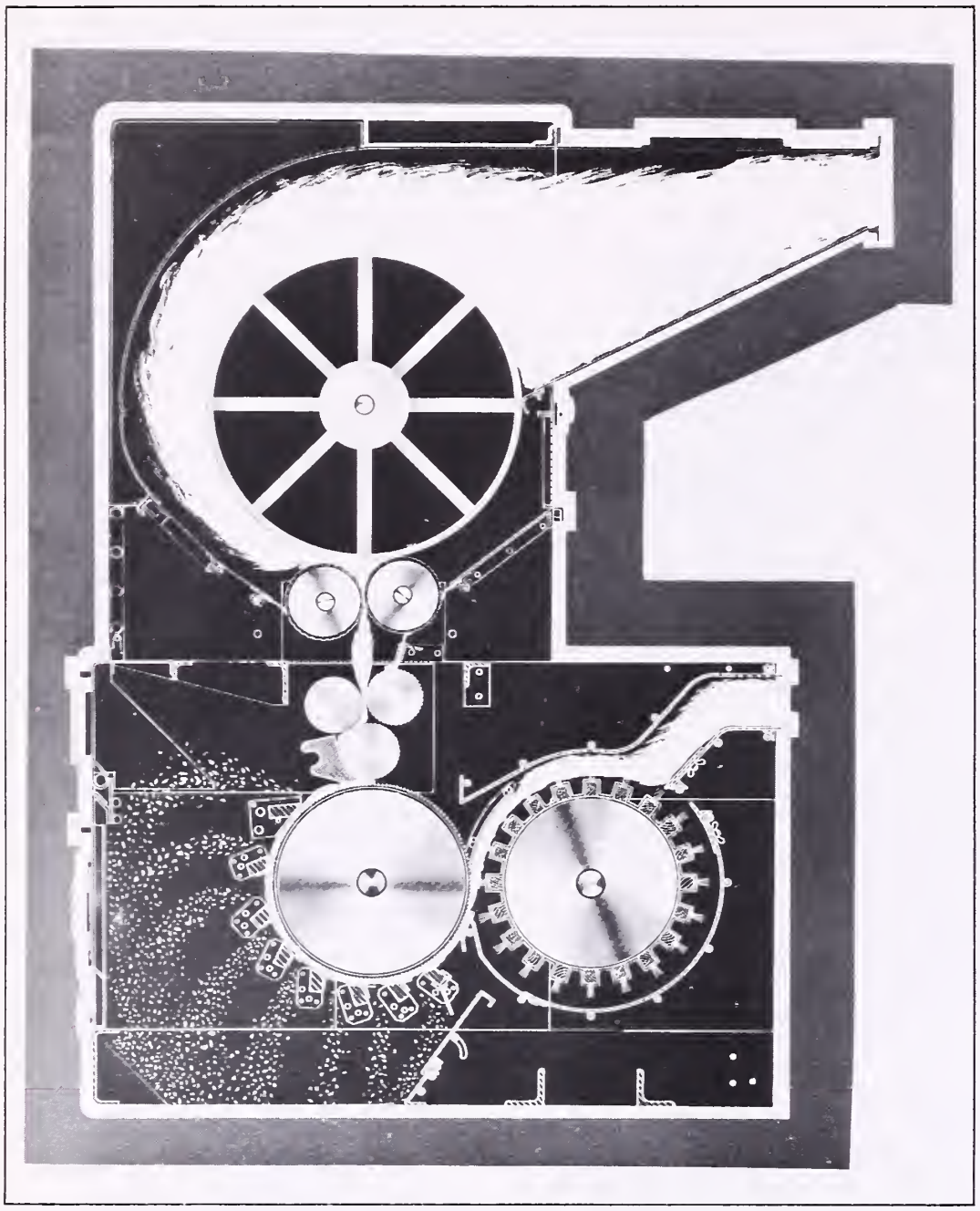


Figure 7: Cross section of a typical saw-type lint cleaner.

Under most circumstances, two lint cleaners will give the best economic returns. In some situations, a third stage of lint cleaning could be feasible and under other circumstances, one lint cleaner would give the highest return. Consequently, ginning systems should be designed so that all lint cleaners after the first stage can be bypassed.

Bale Press

Cotton must be baled and packaged to protect it from contamination during transportation and storage. The U.S. cotton industry has adopted the universal density bale with a nominal density of 28 pounds per cubic foot. Universal density bales may be produced at a compress from modified flat bales, or they may be produced at the gin with a universal density press.

Bale coverings and ties should meet the specifications developed by the joint Cotton Industry Bale Packaging Committee. Detailed specifications are available from your county Agricultural Stabilization and Conservation Service office or from the Bale Packaging Committee, National Cotton Council.

Moisture

Moisture is the most important single factor affecting fiber quality during ginning. When ginning at higher moisture contents, the average length of cotton fibers will be greater than if the same cotton was ginned at low moisture contents. However, trash is easier to remove from drier cotton. Consequently, determining a ginning moisture content is a compromise between good trash removal with some fiber length damage and length preservation with less cleaning.

The ideal ginning moisture content is 7 percent, but moistures between 6 and 7½ percent are acceptable. Ginning at moistures outside this range can cause machinery operation and quality problems.

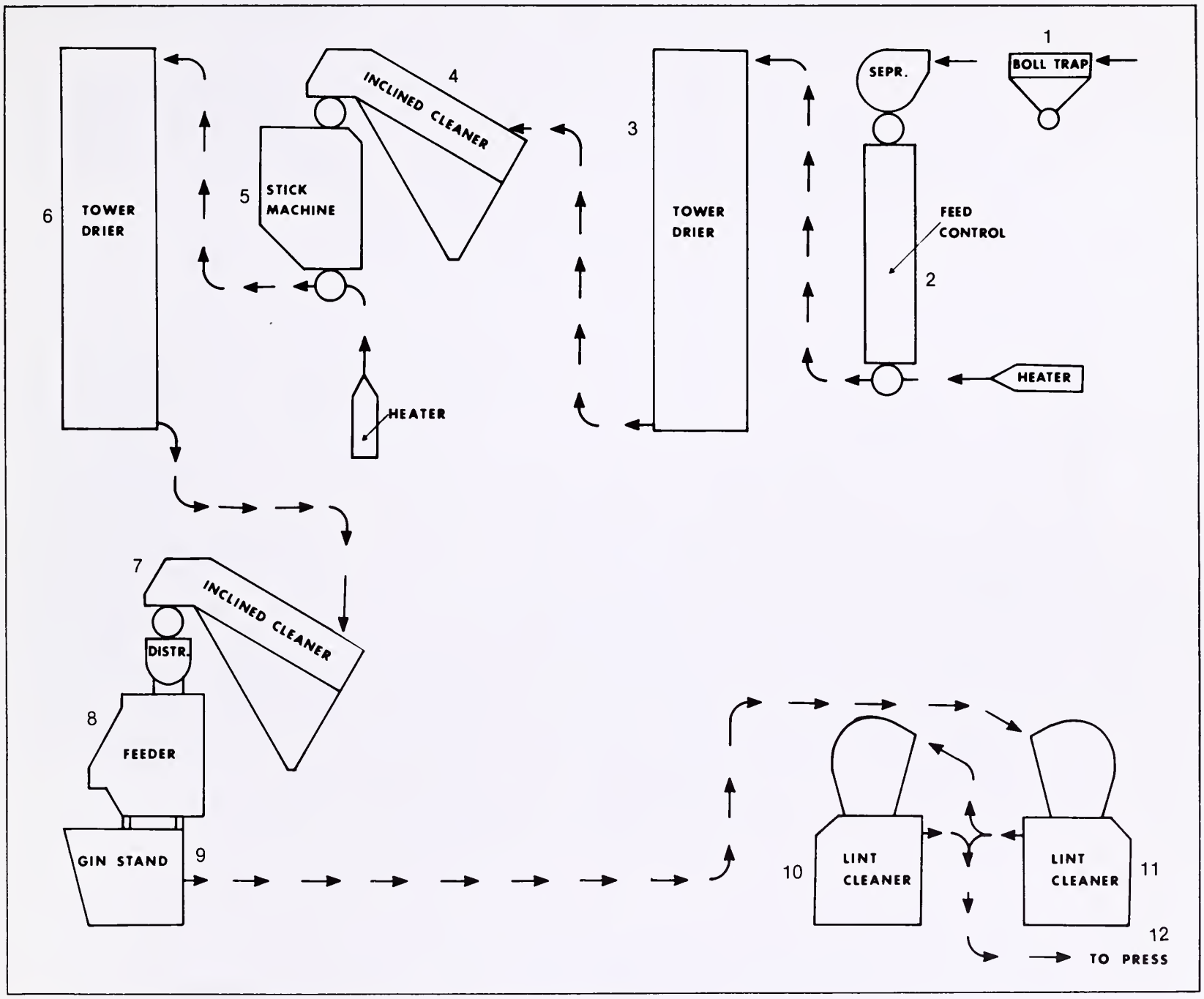


Figure 8: Recommended ginning system for machine-picked cotton.

Machinery Systems Recommendations

Spindle-Picked System

For spindle-picked cotton, the generally recommended machinery sequence is as follows (fig. 8):

1. Rock and green-boll trap
2. Feed control
3. Tower drier
4. Cylinder cleaner
5. Stick machine
6. Tower drier
7. Cylinder cleaner
8. Extractor feeder
9. Gin stand
10. Lint cleaner
11. Lint cleaner
12. Press

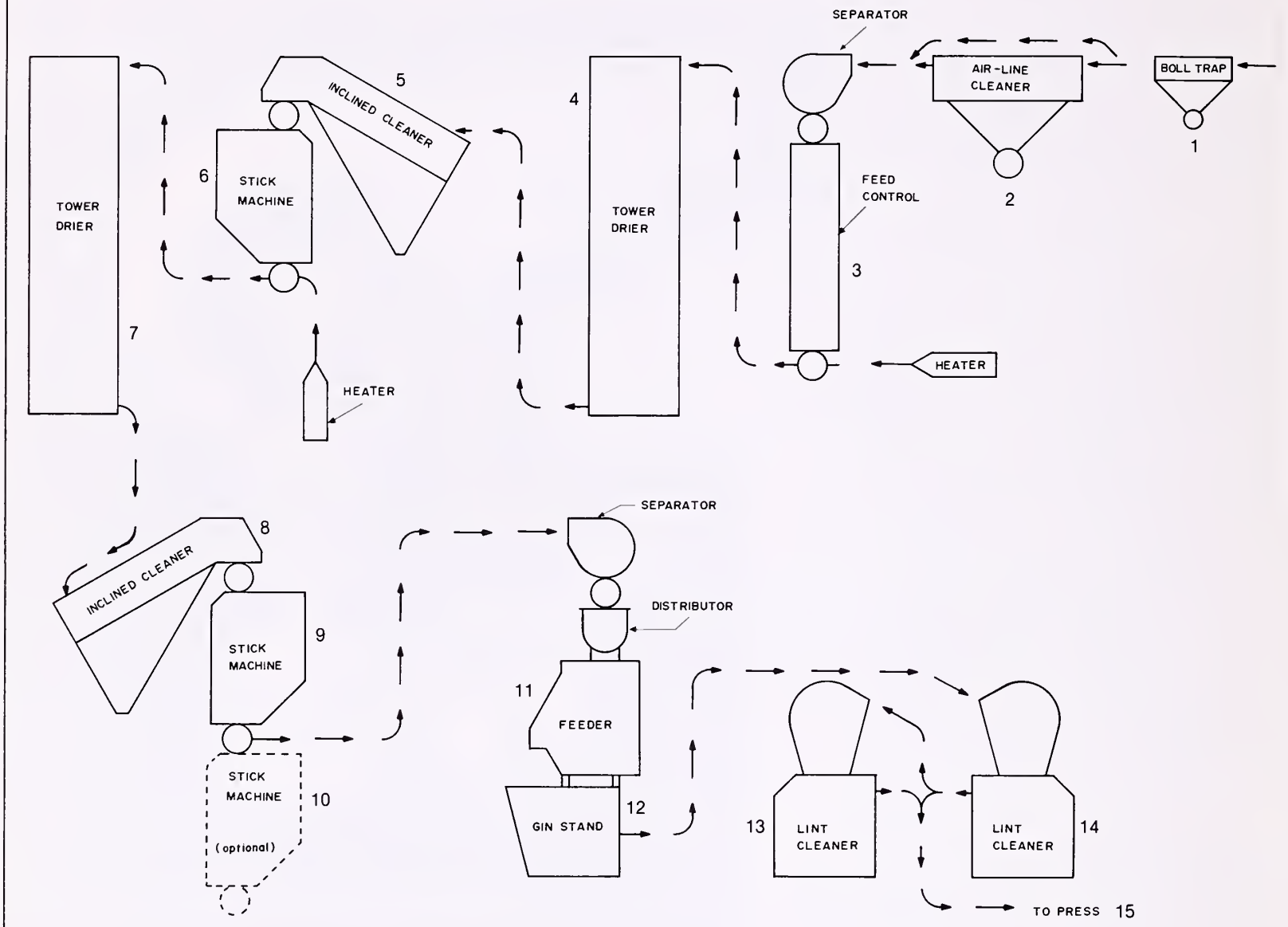


Figure 9: Recommended ginning system for machine-stripped cotton.

Machine-Stripped System

Since machine-stripped cotton that was not cleaned on the harvester contains 6 to 10 times as much foreign matter as machine-picked cotton, ginning systems in stripper areas need more cleaning equipment to maintain fiber quality. The following system of gin machinery (fig. 9) is generally recommended for stripped cottons:

1. Green-boll trap
2. Air-line cleaner
3. Feed control
4. Tower drier
5. Cylinder cleaner
6. Stick machine
7. Tower dryer
8. Cylinder cleaner
9. Stick machine
10. Stick machine (The optional stick machine is recommended only for stripped cotton containing in excess of 32 percent foreign matter (lint turnout less than 22 percent).)
11. Extractor feeder
12. Gin stand
13. Lint cleaner
14. Lint cleaner
15. Press

These recommendations are the maximum amount of machinery that should be needed. Any machinery which is not necessary for the particular lot of cotton should be bypassed. Driers, seed cotton cleaners, and lint cleaners should have bypass valves so they are not used unless they are needed.

Safe Working Conditions

Every employer has the responsibility of providing a safe working environment. Injuries to gin employees are a result of unsafe conditions, unsafe work practices, or unsafe behavior. Each gin should be inspected for unsafe conditions, and corrections made. A general safety program should be developed for each gin, including the education of employees on unsafe conditions, practices, and behavior.

Good housekeeping practices, such as keeping gin machinery and buildings clean, keeping tools and equipment in their place, and making sure all pneumatic systems are in good repair, can reduce the frequency of accidents.

Providing safe, comfortable working conditions is a good business investment when you consider the costs of accidents and health problems. Workers compensation and other insurance rates are based on claim size and frequency. Litigations can also result from injuries. A good safety program can reduce your long-term cost of ginning cotton.